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Telecommunications Executive Governance Committee
Arizona Department of Administration
State Procurement Office
100 N. 15th Avenue, Suite 104
Phoenix, Arizona 85007

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Committee Members,

A Recommended Service Delivery Model

Submitted by FNT, Fiber Network Training and Consulting Services

FNT is a Consultant and Fiber Optic Trainer for: City of Mesa, City of Prescott, City of Phoenix, City of Tucson, Apache Junction, Yuma County, Coconino County, Pima County Engineers, Arizona State University, Boeing, Raytheon, State and Federal Prison Systems, Arizona and U.S. Department of Transportation and the Ak Chin Indian Community, to name a few.

Without a doubt, one of the most critical issues that we all face today is that of ever increasing bandwidth requirements. Just when we believe that we have installed the right capacity of cabling, new technologies for voice, data and video applications emerge with bandwidth requirements that exceed those capabilities.

With over 200 people moving into the Valley each day, we face bandwidth challenges ahead that require a great deal of forethought. Whether our issues concern security applications, traffic management, health and human services or administration of government, clearly the quality of service that we are expected to deliver, centers around our ability to successfully judge bandwidth requirements for today and for the future.

Many municipalities have approached this dilemma in the past but few government bodies have addressed it on a statewide basis. To think that we, or any other state for that matter, could completely resolve a bandwidth shortage overnight would certainly be wishful thinking.

In light of this issue, a Recommended Service Delivery Model might include the methodical and continuous build out of the State's fiber optic infrastructure. By exploiting State owned or controlled right-of-ways, as well as negotiating for privately owned existing path, the State should be in a great position to leverage access to those paths. As a special note, the path (or empty conduit) described here, in large part lies empty due to lack of private investment from the 1999 to 2002 downslide within the industry. This lag in network investment is just

beginning to return, fueled by a better stock market outlook, as well as new fields of interest such as Homeland Security Federal funded projects and more recent projections of impending bandwidth shortages.

Today, fiber optic cable prices have plummeted to new all-time lows due largely to what was declared in the year 2000, as a bandwidth glut across the nation. The fact of the matter is, there was never a bandwidth glut. In fact, three years of doing nothing to match high technology equipment releases such as email and photo delivery systems built into cell phones has created a bandwidth shortage, not just from a State's prospective but also on a National level.

The State, with foresight, could maximize a buyer's leverage in a temporarily down-market, in order to stockpile fiber optic cable, which would be consumed rapidly, even in the most modest deployment efforts. There is little risk involved here, as two primary fiber types dictate a lion's share of the all the fiber produced globally and both can easily be resold back into the new growing market should the State desire to abandon their ambitions in this area.

With impending Homeland Security issues, as well as rejuvenated interest in fiber optic cable deployment by Regional Bell Authorities (See Attachment "A" Wall Street Journal June 10, 2003 article attached); the cost of fiber optic cable will once again rise in the near future as manufacturers stockpiles dwindle.

There may or may not be an easily administered Service Delivery Model when the Committee has completed their assessments. However, to secure an informed, top level consultant who resides in the State of Arizona from the very beginning, would be a very fiber wise start. More often than not, when major project potentials are addressed to the working community, the small and disadvantaged businesses of our State are pushed aside in favor of major consultants and contractors from the east coast, who are perceived as having all the answers and capabilities. I strongly urge the Committee to consider that Arizona's Consultants in the Telecommunications, Data Network and Security Industries represent some of the most knowledgeable talent in our Country.

As a past participant in activities centered around the defunct "Arizona Project Eagle" as well as the latest attempt, "Arizona Project Connect", it was very easy to see the vultures circling from the very beginning of those proceedings. Few of the potential out of State players had the level of expertise or knowledge about our State's needs or geographical restrictions to address Arizona's network infrastructure deficiencies. A fewer number yet, cared less about logical and long-term solutions for the State. What most participants had in common, was that they saw a splendid opportunity to extract money from an unsuspecting and uninformed customer with very deep pockets.

A potential Service Delivery Model should always include a complete analysis into the costs and benefits of deploying a type of cable that will not be soon declared incapable of supporting the traffic. Year after year, we hash over this same issue and year after year, we opt for the lowest price cable that will just barely get us by today, with little thought of future requirements.

Consideration of electronic purchases, although not well regulated for intra-network compatibility, usually suffers little from cost considerations. As fragmented Departments select the electronic equipment needed to successfully complete their daily tasks, more often than not little, if any consideration is given to how a 2.6 to 8 gigabit piece of equipment is going to successfully operate over a 10 or 100 megabit network. The answer to this of course, lies in the "weakest link" scenario. The piece of equipment purchased for it's incredible speed and capabilities will only function externally to the maximum capacity of the network and even then it becomes de-rated depending on the adequacy of design, quality of network cable installation and number of other users on the network. De-rated factors in network bandwidth are rarely addressed until the users find themselves starving for operational bandwidth, yet year after year new computer and switch speeds double, triple or in some cases even quadruple. There are only two words that I can suggest as an all encompassing solution to insufficient bandwidth now and in the future and they are "DEPLOY FIBER". Do this whenever and wherever possible and over time you will virtually eliminate bandwidth deficiencies statewide.

LONG HAUL, INTRA-BUILDING and BACKBONE INFRASTRUCTURES

There are several ways to deal with de-rated bandwidth, especially when the circuit is or can be converted to a fiber optic transport. Very large loads and heavily taxed network backbones can easily be multiplexed onto a single fiber or fiber pair at about $5,000.00 per gigabit transport (port cost analysis derived from a 4 Gigabit Dense Wave Division Multiplexer unit commercially available off-the-shelf). Clearly, the longer Wide Area Network (WAN) connections are far less expensive when they are multiplexed onto just a couple fibers. Examples of this technology, not only exist here in the State of Arizona, but also in the global community, where entire countries such as Mainland Japan are linked with the balance of the world over a hand full of fibers using DWDM architecture. In longer network links, DWDM architecture minimizes the cost of cable deployment by reducing the total number of fibers needed to transport an unlimited amount of information. A benefit by-product of reduced fiber capacity is the radical conduit or pathway space savings as well as installation costs. This type of transport can easily grow or can be modified to multiple channel, 64 gigabit transport signals and beyond, over a single pair of fibers. COX Communications, here in Phoenix, recently deployed this technology in order to increase bandwidth over their existing fiber optic network, enabling them to roll out their new High Definition Television (HDTV) program and expand bandwidth services to the far reaching neighborhoods of the Valley. DWDM network architecture is capable of handling any protocol from conventional Ethernet to multi-channel video signals all on the same fiber pair "simultaneously". It would take tens of thousands of copper pairs to accomplish the same bandwidth as this single fiber pair, when using DWDM architecture. If Committee members are interested in seeing close-up, the technology deployed by COX Communications and learning more about it, FNT has a fully operational 64 Gigabit Channel DWDM operational simulator in our training center at 40th Street and Broadway. FNT also offers training on this subject for city and state planners. A note to consider is that Cox Communications may or may not be a willing participant in the State's plan. If they are, it will no doubt be to the extent that favors their own best interest, not that of the State. Another potential participant, with a great deal of personal gain to be had is Qwest Communications. They of course would be very interested in deploying fiber because through recent FCC rulings, they may not have to share those fiber optic lines with any other providers.

LOCAL AREA NETWORK INFRASTRUCTURES

A way to handle smaller traffic links, with near zero collisions and zero latency, is to deploy fiber in a Centralized Network fashion (as approved and addressed by EIA/TIA 568B). It is a well-known fact that the fiber waveguide transport delivers it's packets at the speed of light (186,000 miles per second in free space). Although a network may only be configured to operate at 100 megabits per second from an electronic transmission standpoint, the true capabilities of the network lie in the cables capabilities and speed of transmission. Copper links will rarely achieve 100% of the specified capability because manufacturer's cable ratings cannot take into account, the way that a designer has loaded up the system with excessive throughput demands. Also adding to network latency is any value less than a perfect installation, including use of degraded patch cables. For example, one single degraded patch cable or a single inferior termination entered into a multiple cable installation, will degrade all circuits to some extent, even though that patch cable is not directly connected in line with those alternate circuits. What causes this phenomenon is the increased network collisions and the necessary repeat of transmissions to successfully deliver the entire packet. Fiber optic cable is immune to this phenomenon, delivering 100% non-degraded signal as long as light can pass across the fiber circuit. Below is a comparison of network port efficiency, copper Distributed against fiber Centralized. As you can see, copper Distributed never comes close to the operational capabilities of the fiber Centralized network.

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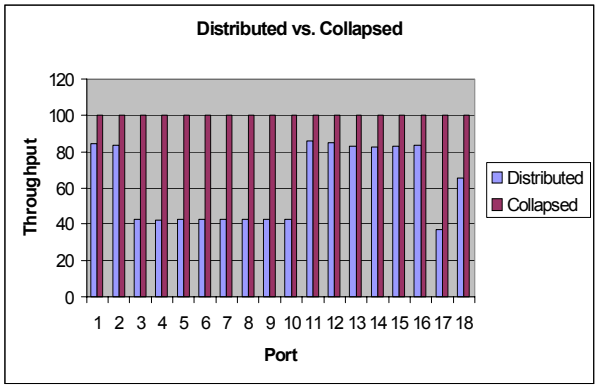
INCREASED THROUGHPUT

The backbone uplinks in a distributed network can easily get oversubscribed, which reduces the overall traffic throughput. This problem is eliminated by collapsing the network and allowing the substantial bandwidth on the core switch to be utilized.

In the previous *"distributed"* network design let us consider the following requirements.
1st Floor – 24, 100 Mb/s users
The switch uplink is 1000 Mb/s.
Therefore, the average backbone bandwidth allocation for each user is approximately, 1000/24 Mb/s = 42 (41.67) Mb/s
This is an average reduction of approximately 58% of the total allocated bandwidth per user.

Although this value is not static at all times it is important to remember that each user is allocated significantly less backbone bandwidth at any given moment. In the *collapsed* design, every user gets 100% of the allocated backbone bandwidth.

A formal experiment was conducted to test this conclusion.
The summary of the results are as follows:



There are many options available in today's switch, router, and component electronic market. Many of these equipment options operate in similar fashion with a respectable degree of compatibility between them. Choosing the right equipment for a specific application does not always mean that one simply looks at what they want to do and then buys the equipment to accomplish the task. The equipment in this case, is only a single piece of the entire puzzle that first must be analyzed, scrutinized and assembled into an entire scheme of functionality. Applying any other method, for buying even a single piece of equipment can result in wasting thousands of dollars and getting little in return. Sound purchasing decisions, plan flexibility and aggressive yet attainable "specific goals" should all be integral parts of the Committee's plan. Rather than strictly writing a single overwhelming RFP or RFQ that will no doubt lock the State into a fixed pattern years to come, the Committee may better control and reach their goals through the issuance of smaller scale RFP's for more specific tasks that fall within the master plan.

SERVICE DELIVERY MODEL SUMMARY

A gradual migration to a total fiber optic Centralized Network platform for Inter-building applications and Wave Division Multiplexing (WDM) or Dense Wave Division Multiplexing (DWDM) for Intra-building and long haul platforms should be strong considerations for a Service Delivery Model. Both architectures employ current, easy to access and coordinate technologies as well as offering a sizable amount of off-the-shelf selections in equipment and cabling options.

Since fiber optic based network platforms or architectures care little about the equipment they are connecting, most existing equipment that is in service now, can still be utilized with only modest signal conversion cost and little or no latency "delay affect" on upgraded network speeds and capacities.

Migrating to a master plan that includes Centralized Networking and DWDM technology such as this would offer extreme flexibility both internally and externally. The cost of deployment is low and more often than not, is less expensive than conventional copper network solutions, as stated in a White Paper by Tolly Group 2000, a Strategic Planner Consultant. A bonus of unlimited bandwidth and easy growth and adaptation capability always accompanies a fiber optic solution when the consultant, planners and everyone involved knows what fiber optic cable can do and how to design for fiber based systems and components.

WHERE TO GET MORE INFORMATION or ASSISTANCE

Training for planners, designers, managers and installers of fiber optic LAN, MAN and WAN systems is available locally every month for those wishing to have a better command of the language and capabilities of transmitting information at the speed of light.

FNT, Fiber Network Training and Consulting Services has been an Arizona business since it's beginning over a decade ago with Corporate offices and Training Center located at 40th Street and Broadway, in Phoenix. Facility tours are free and guests are always welcome.

IN SUMMARY

It is far more feasible to increase capacity and plan for future needs when the delivery system is comprised of fiber optic cable. At extremely limited distances and bandwidth that falls far short of fiber capabilities, copper "at best" can deliver only one gigabit per second, with latency issues and installation concerns that are not a consideration with fiber.

Once again, it is extremely important to utilize a local fiber optic specialist as a Consultant, from design consideration to assisting in the writing of any RFQs. A quality local Consultant is also capable of bringing current industry knowledge to the table, making recommendations based on facts, not opinion and will be very well versed in new fiber optic technologies. This Consultant should also be well versed in Local Area Network LAN analysis and deployment of both fiber and copper as well as Long Distance DWDM Network Architectures and capabilities using various types of single mode fiber, depending on dispersion factors and actual network requirements.

FNT has been assisting State Government, Tribal Communities, School Systems and Commercial ventures in Arizona for over ten years to achieve their bandwidth goals. We stand ready to assist the State Telecommunications Executive Governance Committee, whether in a paid Consultant roll or as non-paid Arizona based constituent with a special interest in seeing our State grow and prosper with service delivery efficiency that is second to none.

We would be pleased to address the committee or any public forum as requested to better define vendor neutral fiber optic solutions, as well as to answer questions regarding the possibilities and costs associated with fiber optics and unlimited bandwidth potentials.

"E-Signature Invoked on this Document"

Jeffrey M. Dominique
President, FNT Fiber Network Training and Consulting Services

Attachment A
Wall Street Journal
June 10, 2003

An Attachment B
Additional Information About
Standards Compliant Centralized Networking
And It's Benefits Can be Obtained by Calling:

602-414-0606
Jeffrey M. Dominique

This is non-vendor specific material.